

Analyzing Energy Consumption Patterns and their Impact on Industrial Sector Performance: A Comparative Study of Selected Countries at Aggregated and Disaggregated Levels

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The relationship between energy use and industrial sector output can play a vital role in adjusting policies regarding energy sector. This paper investigates the causal relation between energy consumption and industrial sector performance in 14 selected countries of world by utilizing panel data from 1993 to 2017. these 14 countries are divided into two groups: high income group and upper middle income group countries. The Auto Regressive Distributed Lag (ARDL) test is used to check the impact of energy consumption in both long-term and short-term. The results of ARDL indicate the presence of long run and short run relationship among the variables. It also reveals that aggregated and disaggregated energy components (ELE, HYD and OIL) have a favorable and significant impact on industrial performance. Oil has more significant impact on industrial sector as compare to other energy sources in both income groups. Labor and capital in both models have remarkable impact on output as per Neo classical output theory, in our aggregated energy consumption model. These results describe the fact that industrial sector of these two income groups needs a great deal of energy. The present study is fairly significant for academic perspective and policy makers as it shows a strong relationship between energy consumption and industrial sector output. According to the findings, improvement of energy sector in said countries will boost the industrial sector's performance.

Keywords: Energy consumption; Industrial output; Auto Regressive Distributed Lag Model. F bound test.

INTRODUCTION

World's rapid growth demands to increase all kinds of energy to keep pace with the level of growth. Energy is considered as a key factor in the production of goods and services in all sectors of an economy, and also has a vital role in improving the standard of living of people all over the world. The importance of energy in fueling economic growth has been widely accepted and numerous studies have been conducted worldwide to find evidence of the significant relationship between these two variables.

During this period of industrialization, the rate at which a nation's economy and society expand is directly proportional to the amount of energy used, as energy is a crucial component of production. The increased energy use boosts production, efficiency, and overall economic growth. In the current scenario, energy is analogous to the blood that flows through the veins of every nation's economic structure. It propels the economy and boosts industrial production, which is the primary driver of economic expansion. Traditional

economics held that labor and capital were the two most important factors in production. However, in the modern era of globalization, the importance of energy utilization cannot be overstated. Energy is a crucial factor in the manufacturing process, alongside monetary resources and human labor.

The fact that energy consumption is increasing across the board proves that energy will be the most significant problem facing the globe in the 21st century. In addition, there will be an increased requirement for renewable and alternative forms of energy. At this point, energy is necessary for production and consumption growth. The choices about energy use in households, businesses, and government agencies have direct and indirect effects on the patterns of economic expansion. The structure of expanding energy demand and its key components are essential for accurately anticipating both existing and future requirements (Okoboi and Mawejje, 2016).

The present study includes 14 selected countries to observe the effect of energy consumption on industrial sector output. In present study we are examining the energy dependence of

different countries which we have divided in two income groups i.e. High income countries and upper middle income countries. In High Income group, Australia, Germany, United Kingdom, France, Italy and Norway are included. While in Upper Middle Income Group, Malaysia, Thailand, Turkey, Iran, Brazil, Colombia and Peru are selected. Energy consumption is essential part of the development of any economy; every country is investing in energy industry due to its importance in every sector. Energy industry of United Kingdom is expanding day by day it supported almost 0.73 million jobs and its investment in energy sector is \$17b which is almost 7% of its total investment. The focus of our research is to show how aggregated and disaggregated energy consumption affects industrial sector performance in respective countries. Many studies have been conducted regarding relation that exists between industrial sector performance and energy use both at aggregated and disaggregated level (Ifeakachukwu, 2017; Mawejje and Mawejje, 2016).

The industrial sector of most of the economies is a main source of economic growth. It has been contributing reasonable share in the development of economy by creating job opportunities and increasing volume of foreign trade largely for the last five decades. In present industrialized era, each production procedure is largely depending on sustainable energy provision. Sustainable energy supply is essential to attain smooth economic development. Thus it is advantageous for under developed and developing economies to recognize the significance of energy utilization to achieve continuous Gross Domestic Product and exports growth. Sustainable energy supply is fundamentally contributing a lot in industrial output. It provides a large share to exports because exports are the main determining factor to achieve economic development. Availability of energy at equitable price lowers down the expenditure of production and in term it makes the home goods competitive and effective in the global market and eventually expands the level of exports and directly affects the GDP of the economy.

LITERATURE REVIEW

As a result of the prevalence of energy issues in today's world, which affects a significant number of countries, analysts analyzed how various economic sectors were impacted by energy use. There are a variety of perspectives on the energy issue. Several recent studies have used econometric models on either one or many data sets. The following are some older researches. Pedroni (1999) used the panel co-integration and causality tests to examine how the variables were related. The research showed that energy use and GDP are connected in all income groups. (Jobert and Karanfil, 2007). Aqeel and Butt (2001) researched Pakistan, focusing on economic development, employment, and energy use. According to the findings, expansion increased energy use. Ghosh (2002)

observed that one way causality was running from development to electricity use (Jumbe (2004) found that bidirectional causal relation was established between electricity use and GDP for Malawi over the time span of 1970 to 1999 (Ewing *et al.*, 2007).

Fatai *et al.*, (2004) evaluated the relation existing between aggregated and disaggregated energy use and GDP growth rate, these results are supported by (Khalid *et al.*, 2007. analyzed that uni-directional causality was present in electricity, coal and energy use and real GDP from the disaggregated side but no causality was being found for oil and GDP (Sari *et al.*, 2008; Rahman *et al.*, 2015). Shiu and Lam (2004) re assess the link between electricity use and GDP in China and empirical findings indicated co integration within real GDP and electricity consumption for China. Lee and Chang (2005) investigated that gas consumption has structural breaks in the 1960s, after taking into account these breaks; the series became stationary so Taiwan applied a policy which expanded exports, (Mahadevan and Asafu-Adjaye, 2007; Amin and Alam, 2018). Chen *et al.*, (2007) investigated and revealed that uni directional causality existed between GDP and electricity use in the short run and two-way causality was running from GDP to electricity (Ciarreta and Zarraga, 2009). Lise and Van (2007) found that GDP and energy consumption would grow in future by 7% and 5.9% annually till 2025 in Turkey (Erbaykal, 2008; Asghar, 2008; Lean and Symth 2010) revealed that the link between CO2 levels and economic growth for these countries runs in just one direction. (Belloumi, 2009; Tsani, 2010)

Behera (2015) demonstrated that economic progress leads to a rise in electricity consumption. The findings indicated only a correlation in one direction between GDP growth and natural gas use. Tariq *et al.* (2018) used instrumental variable regression to look at how the economies of Pakistan, Sri Lanka, India, and Bangladesh have grown and how much energy they use. Energy shocks could hurt the growth of these economies. For economic growth, policy makers should recommend efficient energy sources, these findings are also supported by (Tsani, 2010; Rezitis and Ahammad, 2016). Ahmad and Ramzan (2019) that using energy as a whole and using it in different ways helped the economy of Pakistan. (Asghar, 2008; Dedeoglu and Kaya, 2013).

MATERIALS AND METHODS

Data: The present study included 14 selected countries of the world to find out impact of aggregated and disaggregated energy consumption regarding industrial sector output. In this study, data is taken of both time series and cross sectional form. Industrial output is used as dependent variable while aggregated energy consumption, disaggregated energy components (oil, electricity and hydro electricity), employment, gross capital formation, foreign direct investment, inflation and CO2 emission are employed as



independent variables. Industrial output, oil, foreign direct investment and gross capital formation are taken as % of GDP while electricity and hydro electricity are taken as % of total consumption. Total energy consumption is used as kg of oil equivalent per capita and inflation as annual %. Co2 emission is taken as metric tons per capita.

To check the relationship between dependent and independent variables used in present study, twenty five year's time series data from 1993-2017 from selected 14 countries is being employed. In present study two models are developed. In our models dependent variable is industrial output (% of GDP) and in first model we made aggregate analysis. While in our second model disaggregate analysis is done. The major objective of the research is to find the impact of independent variables on dependent variable in both models. The Autoregressive distributed lag (ARDL) model is employed to check the long run relationship between dependent and independent variables.

Model Specification: Two models are developed in current study. The first model shows the association between aggregate energy consumption and industrial output while second model reveals the interconnection between energy consumption and industrial productivity in the disaggregate analysis.

Long run model for aggregate energy consumption and industrial performance

$$(IND)_t = \alpha_0 + \sum_{i=1}^{p_1} \alpha_1(IND)_{t-i} + \sum_{i=0}^{p_2} \alpha_2(GFC)_{t-i} + \sum_{i=0}^{p_3} \alpha_3(FDI)_{t-i} + \sum_{i=0}^{p_4} \alpha_4(TEC)_{t-i} + \sum_{i=0}^{p_5} \alpha_5(EMP)_{t-i} - \sum_{i=0}^{p_6} \alpha_6(INF)_{t-i} + \sum_{i=0}^{p_7} \alpha_7(CO_2)_{t-i} + \varepsilon_t$$

Short run estimates of aggregate energy consumption and industrial output

$$\Delta(IND)_t = \eta_0 + \sum_{i=1}^{n_1} \eta_1 \Delta(IND)_{t-i} + \sum_{i=0}^{n_2} \eta_2 \Delta(GFC)_{t-i} + \sum_{i=0}^{n_3} \eta_3 \Delta(FDI)_{t-i} + \sum_{i=0}^{n_4} \eta_4 \Delta(TEC)_{t-i} + \sum_{i=0}^{n_5} \eta_5 \Delta(EMP)_{t-i} - \sum_{i=0}^{n_6} \eta_6 \Delta(INF)_{t-i} + \sum_{i=0}^{n_7} \eta_7 \Delta(CO_2)_{t-i} + \lambda(ECM)_{t-1} + \mu_t$$

Long run estimates of disaggregate energy consumption on industrial output

$$(IND)_t = \alpha_0 + \sum_{i=1}^{p_1} \alpha_1(IND)_{t-i} + \sum_{i=0}^{p_2} \alpha_2(GFC)_{t-i} + \sum_{i=0}^{p_3} \alpha_3(FDI)_{t-i} + \sum_{i=0}^{p_4} \alpha_4(EMP)_{t-i} + \sum_{i=0}^{p_5} \alpha_5(INF)_{t-i} - \sum_{i=0}^{p_6} \alpha_6(CO_2)_{t-i} + \sum_{i=0}^{p_7} \alpha_7(ELE)_{t-i} + \sum_{i=0}^{p_8} \alpha_8(HYD)_{t-i} + \sum_{i=0}^{p_9} \alpha_9(OIL)_{t-i} + \varepsilon_t$$

Short Run Estimates of Disaggregate Energy Consumption on industrial output

$$\Delta(IND)_t = \eta_0 + \sum_{i=1}^{n_1} \eta_1 \Delta(IND)_{t-i} + \sum_{i=0}^{n_2} \eta_2 \Delta(GFC)_{t-i} + \sum_{i=0}^{n_3} \eta_3 \Delta(FDI)_{t-i} + \sum_{i=0}^{n_4} \eta_4 \Delta(TEC)_{t-i} + \sum_{i=0}^{n_5} \eta_5 \Delta(EMP)_{t-i} - \sum_{i=0}^{n_6} \eta_6 \Delta(INF)_{t-i} + \sum_{i=0}^{n_7} \eta_7 \Delta(ELE)_{t-i} + \sum_{i=0}^{n_8} \eta_8 \Delta(HYD)_{t-i} + \sum_{i=0}^{n_9} \eta_9 \Delta(OIL)_{t-i} + \lambda(ECM)_{t-1} + \mu_t$$

Empirical Results and Discussion: Stationarity of panel data is much important to check for an authentic analysis. In stationary process, it is assumed that mean, variance and auto correlation remain constant. It is commonly observed that mostly data is found non stationary. When the data is not stationary, it is essential to convert it into stationary series. In present study, the stationarity of data is checked by using Levin, Lin & Chu t*. By applying these tests, we found series is not stationary at level. So, we differentiated it. Table 1 depicts the results of panel unit root tests which show some variables are stationary at level and some are stationary of order 1.

Table 2 shows stationarity of the variables is checked by using Levin, Lin and Chu t* Stationarity shows that mean, auto correlation and variance of a data series are constant over time. The results shows IND is stationary at level for HIC and of difference 1 for UMIC. TEC is stationary at 1st difference for both HIC and UMIC. OIL is stationary at level for HIC while at 1st difference for UMIC. ELE is stationary of order 1 both for HIC and UMIC. HYD is stationary at 1st difference for both groups and CO2 is stationary at 1st difference for HIC and UMIC. EMP is stationary of order 1 for HIC and UMIC and the results of GCF, INF and FDI are also stationary at

Table 1. Panel Unit Root Test (LLC) Results of HIC.

Variables	LLC TEST RESULTS					
	Level			1 st Difference		
	Intercept	P-value	Trend & intercept	P- value	Intercept	P-value
IND	-3.74	0.00				
TEC	1.26	0.89	-1.87	0.03	-12.80	0.00
Oil	-2.24	0.01				
ELE	1.52	0.93	-1.94	0.42	-9.48	0.00
HYD	1.82	0.96	3.73	0.99	-6.26	0.00
CO2	-0.82	0.20	0.64	0.73	-6.69	0.00
EMP	-2.17	0.01	-1.66	0.04	-3.90	0.00
GCF	-1.54	0.06	-1.05	0.14	-9.83	0.00
INF	-4.90	0.00				
FDI	-5.78	0.00				



Table 2. Panel Unit Root Test Results (LLC) of UMIC

Variables	LLC TEST RESULTS					
	Level			1 st Difference		
	Intercept	P-value	Trend & intercept	P-value	Intercept	P-value
IND	-1.01	0.15	1.20	0.88	-7.70	0.00
TEC	-0.25	0.39	-0.15	0.44	-11.78	0.00
Oil	-1.57	0.05	-0.59	0.27	-11.25	0.00
ELE	-0.19	0.42	1.35	0.91	-7.51	0.00
HYD	-0.42	0.33	1.63	0.94	-8.52	0.00
CO2	2.95	0.99	3.72	0.99	-3.46	0.00
EMP	-0.81	0.20	2.36	0.99	-5.99	0.00
GCF	-1.50	0.06	-0.66	0.25	-12.04	0.00
INF	-12.34	0.00				
FDI	-4.16	0.00				

Table 3. F-Bound Test Results – Industrial Sector/ Aggregated Energy Consumption.

Income group	F-Statistic calculated	Upper bound	Critical value	Conclusion
High income countries	28.10	3.99	1%	Co integration exists
Upper middle income countries	24.92	4.05	1%	Co integration exists

Table 4. F-Bound Test Results – Industrial Sector/ Disaggregated Energy Consumption

Income Group	F-Statistic calculated	Upper Bound	Critical value	Conclusion
High income countries	18.28	3.91	1%	Co integration exists
Upper middle income countries	33.91	4.43	1%	Co integration exists

level for both income groups. So the results of unit root tests of both income groups give a good reason to apply Auto Distributive Lag (ARDL) model.

Table 3 interprets that null hypothesis which states that there is no correlation among variables is rejected. The calculated F- statistic value for industrial sector keeping in view aggregated energy consumption is 28.10 for high income countries that is more than upper bound critical value 3.99 at 1% significance, so null hypothesis is rejected. As far as the case of upper middle income countries, F-statistic value is 24.92 and the upper bound value is 4.05 at 1 %. It shows that F-statistic is more than critical upper bound value, so the long run relation exists between the dependent and independent variables (Li *et al.*, 2021).

The tabulated F- statistic value for industrial sector regarding disaggregated energy consumption is 18.28 for high income countries that is more than upper bound value 3.91 at 1% significance. So null hypothesis is not accepted and results reveals co integration is found between the variables. For upper middle income countries, F-tabulated value is 33.9 and the upper bound value is 4.43 at 1% significance level. It shows that F-statistic is more than critical upper bound value, so the long run relation is present between the variables. The results of F bond test depicts that industrial output is highly associated with capital, labor, aggregated and disaggregated energy use, CO₂, FDI and inflation. The value of F-statistics is more than the upper limit I₁ which depicts that long run relationship exists among variables.

Table 5 shows the estimated results of ARDL approach both for long and short run of HIC. Here in this model we have taken industrial output as dependent variable while total energy use, CO₂, FDI, inflation, gross capital formation and employment are taken as independent variables. The long run results presented in above table depicts that GCF, Inflation and total Energy consumption has positive and significant impact except FDI on industrial sector of high income countries. CO₂ and employment has negative and significant impact on industrial sector of HIC. The coefficient of total energy consumption suggested that one percent increase in TEC will increase the industrial production by 19% in HIC and 4% in UMIC. The results of this study are same as the results of Chebbi and Boujelbene (2008), Soytaş and Sari (2007) and Ewing (2007). The result shows that 1% increase in FDI will lead to increase the industrial output by .02 percent and 1.17 % in HIC and UMIC respectively (Hussain *et al.*, 2011; Chang *et al.*, 2001; Erdal *et al.*, 2008). When we use energy in an efficient manner, the industrial productivity increases which leads to economic strength. INF and EMP both are positive but having insignificant impact on industrial output in UMIC (Iscan and Osberg, 1998). The short run ARDL outcomes are also depicted in above table which shows instantaneous positive but insignificant impact of CO₂ and INF on industrial output level but lagged effect of CO₂ is negative and statistically significant. On the other hand, inflation has positive but insignificant impact with first lag and positive but significant effect with second lag (Aslan and



Table 5. Panel ARDL Results of Industrial Sector (Aggregate Analysis)

Variable	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
ARDL Long Run Results of HIC				ARDL Long Run Results of UMIC		
TEC	19.30	6.41	0.00	4.29	3.33	0.00
FDI	0.02	0.62	0.53	1.17	2.42	0.01
GCF	0.52	4.07	0.00	0.22	2.86	0.00
INF	0.61	3.84	0.00	0.12	1.36	0.17
CO2	-0.70	-3.14	0.00	-2.09	-4.12	0.00
EMP	0.58	6.73	0.00	0.01	0.11	0.90
ARDL Short Run Results of HIC				ARDL Short Run Results of UMIC		
IND(-1)	-0.25	-3.56	0.00	0.11	1.52	0.12
CO2	0.24	1.46	0.14	0.62	1.27	0.20
CO2(-1)	-0.43	-2.59	0.01	-0.32	-0.72	0.46
CO2(-2)	-0.77	-5.18	0.00	-1.38	-4.66	0.00
FDI	-0.05	-0.88	0.37	-0.07	-0.41	0.67
FDI(-1)	0.09	1.62	0.10	0.28	1.59	0.11
GCF	-0.09	-0.95	0.33	0.13	2.02	0.04
GCF(-1)	0.52	5.41	0.00	0.13	2.48	0.01
INF	0.04	0.26	0.79	0.11	1.36	0.17
TEC	7.49	4.19	0.00	9.10	4.53	0.00
TEC(-1)	7.48	3.08	0.00	-8.28	-4.49	0.00
TEC(-2)	15.2	4.86	0.00	-2.18	-1.20	0.22
EMP	-0.05	-0.73	0.46	0.37	6.31	0.00
EMP(-1)	-0.52	-7.55	0.00	-0.26	-4.12	0.00
EMP(-2)	-0.10	-1.21	0.22	0.14	2.28	0.02
CO2	-0.70	-3.14	0.00	-2.18	-1.20	0.22
EC=IND-(-0.70*CO2+0.02*FDI+.52*GCF+0.61*INF+19.35*TEC+0.58*EMP-109.7)				EC=IND-(-2.093*CO2+0.016*GCF+0.1249*EMP+1.17*FDI+0.225*INF+4.2909*TEC)		
R-Square = 0.90 = Adjusted R-squared = 0.88F-statistic = 53.2Prob(F-statistic) = 0.00Mean dependent var = 24.5Durbin-Watson stat = 1.86				R-Square = 0.89Adjusted R-squared = 0.87F-statistic = 60.2Prob(F-statistic) = 0.00Mean dependent var = 33.4Durbin-Watson stat = 1.81		

Note: Results are based on Author's calculations using E-Views 10.

Korap, 2009). FDI has negative and significant lagged effect at 10%. EMP also has negative but significant effect on industry in short run with lagged form. Total energy consumption has positive and significant effect on industrial output of high income countries depicting 1% increase leading to 7.4 % rise in output of industry. These outcomes are consistent to the findings of Lau *et al.*, (2011).

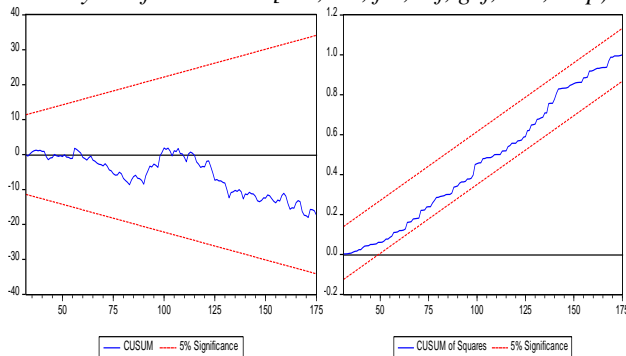
Table 6 shows the empirical results of ARDL technique both for long run and short run. Here in this model industrial output is considered as dependent variable and OIL, ELE, HYD, CO2, FDI, inflation and gross capital formation are taken to be as independent variables. The long run results reveal that all the disaggregated components of energy (OIL, ELE, and HYD) have positive and significant impact over industry in the long run for high income countries. The findings are similar to the results of the studies of (Chandran, 2010; Chaudhry, 2012; Soytaş and Sari, 2007; Ewing, 2007; Liu, 2013). All these studies resulted that by increasing and efficiently using energy components industrial production can

be increased with decreasing cost. The short run results indicate that OIL, ELE and HYD have positive and significant effect on industrial output. Above table also demonstrates the disaggregate analysis industrial sector of UMIC for long and short run. The long run results show that disaggregated sources of energy, OIL and HYD have positive and significant effect on industry in the long run for UMIC. ELE has positive but insignificant impact over output level. CO2 is negatively and significantly affecting the industrial sector while FDI and GCF also have positive and significant impact on industrial sector of UMIC. Inflation is positive but insignificant while EMP has positive and significant impact on industry. The short run results show that ELE and HYD have positive and significant lagged effect on industrial output, (Mawejje and Mawaeje, 2016). OIL is positively and significantly affecting the industries (Ramzan and Kiani, 2012; Bekhet and Harun, 2012; Lise and Montfort, 2007).



Table 6. Panel ARDL Results of Industrial Sector (Disaggregate Analysis)

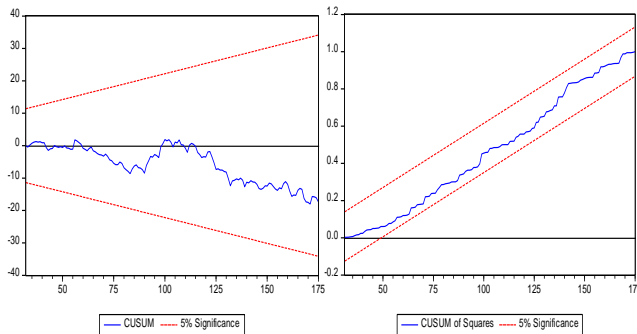
Variable	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
ARDL Long Run Results of UMIC			ARDL Long Run Results of UMIC			
CO2	-0.52	-1.73	0.08	-1.35	-2.56	0.01
EMP	0.22	2.59	0.01	0.40	2.31	0.02
FDI	0.11	1.25	0.21	1.09	2.88	0.00
GCF	0.94	4.59	0.00	0.10	2.25	0.02
INF	-0.59	-1.94	0.05	0.13	1.37	0.17
ELE	0.14	3.10	0.00	0.03	0.31	0.75
HYD	0.18	4.56	0.00	0.23	3.28	0.00
OIL	1.20	3.77	0.00	0.64	6.38	0.00
ARDL Short Run Results of HIC			ARDL Short Run Results of UMIC			
IND(-1)	0.34	5.43	0.00	-0.03	-0.42	0.67
CO2	0.38	2.63	0.00	0.19	0.54	0.58
CO2(-1)	0.36	2.00	0.04	-1.59	-4.91	0.00
EMP	-0.13	-2.37	0.01	0.34	5.45	0.00
EMP(-1)	-0.13	-1.67	0.09	-0.16	-2.22	0.02
EMP(-2)	0.12	1.85	0.06	0.10	1.58	0.11
FDI	-0.02	-0.46	0.64	-0.20	-1.35	0.17
FDI(-1)	0.05	1.12	0.26	-0.08	-0.53	0.59
FDI(-2)	-0.10	-2.38	0.01	0.70	4.32	0.00
GCF	0.43	5.69	0.00	0.10	2.30	0.02
INF	0.11	0.86	0.39	0.02	0.40	0.68
INF(-1)	-0.29	-2.31	0.02	0.11	1.59	0.11
ELE	0.02	1.46	0.14	0.02	0.65	0.51
ELE(-1)	-0.01	-0.56	0.57	0.09	2.19	0.02
ELE(-2)	0.09	3.97	0.00	0.13	2.67	0.00
HYD	0.08	4.02	0.00	-0.03	-0.71	0.47
HYD(-1)	-0.04	-1.75	0.08	0.09	2.53	0.01
HYD(-2)	0.09	4.53	0.00	0.17	4.37	0.00
OIL	1.56	11.2	0.00	0.39	5.09	0.00
OIL(-1)	-0.66	-4.67	0.00	0.26	3.14	0.00
EC=IND-(-0.52*CO2+0.22*EMP+0.11*FDI+0.94*GCF+0.59*INF+0.14*ELE+0.18*HYD+1.20*OIL)			EC=IND-(-1.35*CO2+0.03*ELE+1.09*FDI+0.10*GCF+0.23*HYD+0.13*INF+ 0.64*OIL)			
R-Square = 0.92 Adjusted R-squared = 0.91 F-statistic = 65.3			R-Square = 0.93 Adjusted R-squared = 0.90 F-statistic = 88.9			
Prob(F-statistic) = 0.00 Mean dependent var = 33.4 Durbin-Watson stat = 1.64			Prob(F-statistic) = 0.00 Mean dependent var = 24.4 Durbin-Watson stat = 1.86			

stability test for model 1 [ind, tec, fdi, inf, gcf, co2, emp)

Cumulative Sum and Cumulative Sum of Squares of Recursive Residual: The diagnostic tests are plotted for the model in above diagrams. The findings show that null hypothesis is accepted which describes that no serial correlation exists among the variables. Cumulative sum of the residuals and cumulative sum of square of the residuals are utilized to ensure the stability and it reveals that model is specified as the plotted residuals lie in between the critical bounds.

Stability Test for Model 2 [IND, OIL, ELE, HYD, FDI, INF, GCF, CO2, EMP)





Cumulative sum and cumulative sum of squares of recursive residual: The diagnostic tests are plotted for the model in above diagrams. The findings show that null hypothesis is accepted which describes that no serial correlation exists among the variables. Cumulative sum of the residuals and cumulative sum of square of the residuals are utilized to ensure the stability and it reveals that model is specified as the plotted residuals lie in between the critical bounds.

Conclusion and Suggestions: The aim of the research is to investigate the dynamic relationship of energy consumption and industrial performance in long run as well as in short run. To achieve desired objective, ARDL econometric model is applied. The results showed that aggregate as well as disaggregate energy consumption and industrial output of higher and upper middle income groups are related with one another in long and short run. It is also observed that energy consumption significantly and positively affects the industrial output. There is positive and considerable correlation of labor, capital, TEC, INF and CO₂ with industrial output for HIC. While positive and significant relationship between industrial output and TEC, FDI, GCF, CO₂ and EMP is observed. As supply of energy increases, industrial sectors have more chances to increase their energy consumption in production process which will increase the output level of industrial sector in selected countries.

The impact of capital and inflation on dependent variable is mix in disaggregate analysis. The impact of hydro energy, oil and total electricity on industrial sector is positive in HIC countries. As the energy consumption increases the output of industrial sectors in all income groups increases. Only oil has negative effect on some countries, the reason behind this negative relationship is that oil is an expensive source of energy so as the usage of oil increases the total expenditure to produce a product increase which negatively affects the output level.

This current research on aggregated and disaggregated energy consumption and industrial output both in HIC and UMIC has many policy recommendations. The observed analysis has exhibited the strong and significant relationship between energy consumption and industrial output in HIC and UMIC. Energy consumption increases the production level of

industrial sector in both income groups. While in disaggregate analysis it is revealed that oil consumption has large influence on production of industrial sector and contributing a dominant part in economic development. By analyzing the ultimate significance of energy consumption, the authorities should make policies to increase energy supply and also invest in energy sector to built strong energy infrastructure. Energy industry put the economy on the way of recovery and progress and then foreign investors will also have incentive to invest in this sector. Policies regarding energy conservation should be implemented by the competent use of energy in the manufacturing process. Energy conservation policies keeping in view both total energy and disaggregated energy uses should be adopted in such an efficient way that development in these energy sectors encourages the expansion in industrial sector. The governments of the concerned countries should rely on cheaper and renewable energy sources as well as focus on those energy sources that are environment friendly. The concerned countries should mobilize their potential energy sources to produce more energy. Power plants should be given appropriate attention and uninterrupted power supply should be guaranteed for industrial sector as it is the main contributor of the economies.

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